REMARKS

Introduction and status of the claims

- Claims 21-23, 26-28, 30, 32, 34, and 42-50 are now pending in this application.
- Claim 21 has been amended.
- Claim 50 has been added.
- Claims 21 and 50 are in independent form.

Applicant Request for Interview

While this Amendment is believed clearly to place this application in condition for allowance, if the Examiner should still believe that issues remain outstanding, the Examiner is respectfully requested to contact Applicants' undersigned attorney in an effort to resolve such issues and advance the case to issue. Thus, Applicants hereby formally request an Interview for the purpose of discussing this response with the Examiner.

The Information Disclosure Statement of September 30, 2010

At paragraph 2 of the Office Action, the Examiner states that a number of the references listed in the IDS filed on September 30, 2010 have not been considered because no copies of these references were provided. The Examiner is respectfully incorrect on this point. The undersigned attorney can see copies of these references on PAIR. Accordingly, the Examiner is respectfully requested to consider all of the references listed in that IDS and acknowledge the same.

The rejections under 35 U.S.C. § 103

- Claims 21 and 22 were rejected under 35 U.S.C. § 103(a) as being unpatentable over GB 2155194 A to Bennion et al. in view of EP 0273703 A2 to Elchelberger et al.

- Claims 23, 26, 27, 32, 42-46, and 48 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bennion et al. in view of Elchelberger et al., and further in view of U. S. Patent Application Publication No. US 2004/0001661 to Iwaki et al.

- Claims 28 and 30 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bennion et al. in view of Elchelberger et al., and further in view of Iwaki et al., and still further in view of U.S. Patent No. 6,684,007 B2 to Yoshimura et al.

- Claim 34 was rejected under 35 U.S.C. § 103(a) as being unpatentable over Bennion et al. in view of Elchelberger et al. and further in view of Iwaki et al., and still further in view of U.S. Patent No. 5,255,070 to Pollak et al.

- Claims 47 and 49 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Bennion et al. in view of Elchelberger et al. and further in view of Iwaki et al., and still further in view of the publication entitled "Two-photon polymerization initiators for three-dimensional optical data storage and microfabrication" by Cumpston et al.

1. Claim 21 has also been amended herein to include the feature that the optoelectronic component is embedded in the optical layer, such that the optoelectronic component rests on the substrate and otherwise is enclosed by the optical material of the optical layer or the optoelectronic component is completely embedded in the optical material of the optical layer. Support for this feature is found in the originally filed application, e.g., at page 6, paragraph

3; page 9, paragraph 2, and the sectional views in the drawings.[1]

Claim 21 has been further amended herein to recite that the optical waveguide structure adjoining the opto-electronic component within the optical layer is produced by photon irradiation in a two photon absorbtion process. In contrast to this, as further explained below, Bennion et al. relies upon UV radiation of a photochrome material.

2. The claimed subject-matter was rejected for obviousness based on Bennion et al. and Elchelberger et al., which is traversed below based on amended independent claim 21.

GB 2 155 194 A (Bennion et al.) discusses the production of optical connections between guided wave components. According to the only embodiment shown in Fig. 1, a semiconductor laser 10 and a modulator 12 are provided on a common semiconductor substrate 14. The laser 10 comprises an active layer 16, which is connected to a waveguide 18 of the modulator 12 via a waveguide channel 22. The waveguide channel 22 is produced by depositing a photochromic material between the laser 10 and the modulator 12 on the support 14 (Fig. 2). The photochromic material is then exposed to UV radiation from a UV laser source 51, which is focused on the substrate 14 via a lens 54 (Fig. 5). The region of the photochromic material irradiated with the UV light is converted from an uncolored state having a low-refractive-index to a colored state having a higher refractive-index, thereby forming the waveguide channel 22 (Fig. 3). After the channel 22 has been formed, the whole device is hermetically sealed in a container or envelope, which is opaque to light and excludes oxygen, in order to prevent the colored form of the photochromic material to revert

[1]It is of course to be understood that the references to various portions of the present application are by way of illustration and example only, and that the claims are not limited by the details shown in the portions referred to.

to the colorless form (cf. p. 3, l. 3-5 of Bennion et al.).

As already acknowledged by the Examiner, Bennion et al. fails to disclose the production of a printed circuit board element. It should be noted that Bennion et al. contains no hint that a printed circuit board element could be produced in the known method for producing optical interconnections between sources and detectors of laser light. A person having ordinary skill in the art would have had no motivation or incentive to apply this technique in the field of printed circuit board elements. For this reason alone, the claimed printed circuit board cannot be an obvious modification of the Bennion system. However, as will be detailed below, the different application goes hand in hand with a different design.

The amendments to the claimed subject matter even more precisely distinguish the invention over the prior art including Bennion et al., which is only applicable to a different type of laser-modulator system.

According to amended claim 21, the optoelectronic components are embedded within the optical material such that the components are <u>enclosed</u>, i.e. surrounded, by the optical material. In stark contrast to this, according to Bennion et al. the photochromic material is merely deposited <u>between</u> the laser-modulator elements 10, 12, whereas the remaining faces of the laser 10 or the modulator 12 are left uncovered by the photochromic layer. The claimed construction is advantageous in that the embedded optoelectronic components and their respective contacts are protected both from chemical and mechanical influences. Furthermore, the printed circuit board element including the embedded optoelectronic components can be easily processed, e.g., by providing a further PCB layer on top of the surface of the optical material. Contrary to this, the components etc. would need separate protection (casing/envelope) in the case that the technique of Bennion et al. would be applied.

As has been mentioned before, Bennion et al. requires a separate container or envelope to hermetically and opaquely seal the device. The reason for this is that Bennion et al. relies upon the conversion of a photochromic material from an initially uncolored state to a colored state, which is a reversible process. In order to prevent the waveguide channel from converting back to the colorless state - and thereby losing its functionality - the separate container has to be opaque and gas tight. Accordingly, any modification of the disclosed design according to the claimed subject-matter - i.e., replacing the container by a surrounding optically active material - would lead to a malfunctioning device. Thus, it cannot be obvious to modify the design of Bennion et al. to arrive at the claimed construction, either.

As a further significant distinction from Bennion et al., which is strongly related to the different design explained above, the optical layer according to the claimed subject matter is produced by photon irradiation <u>in a two photon absorption (TPA) process</u>.

The TPA structuring, which is of course known *per se*, relies upon the irradiation of the optical material with a focused laser beam, whose intensity in the focal area is so high that the optical material will absorb two photons, thereby triggering a chemical reaction (cf. p. 4, last paragraph and p. 5, first paragraph). A person having ordinary skill in the art would be aware that the TPA process - in contrast to the UV light assisted conversion of a photochromic material according to Bennion et al. - is an <u>irreversible</u> process, which results in a permanent waveguide structure between the optoelectronic components of the printed circuit board.

Furthermore, the reversible conversion of the photochromic material taught by Bennion et al. could not produce a printed circuit board element with a waveguide having a three-dimensionally adjusted shape, which, according to the claimed subject matter, may be achieved by adjusting the focal area of the emitted laser beam in terms of a depth within the

optical layer.

In contrast to this, the known technique is incapable of producing waveguides with a complicated three-dimensional shape. Bennion et al. mentions that fine positioning of the incident laser beam in the depth of the layer can be achieved by a translationally movable focusing mount 56 (cf. p. 2, l. 55 - 58 of Bennion et al.). However, this fine positioning of the laser beam may only adjust the maximum depth of the waveguide channel 22, whereas the waveguide channel 22 is limited to adjoin the upper surface of the optical material, as can be immediately obtained from Figs. 3 and 4 of Bennion et al. The reason for this is that the UV irradiation - a one photon process - results in a conversion of the photochromic material from the surface of the material (where the UV light enters the material) into the depth of the photochromic material, whereas the TPA structuring according to the invention only transforms the focus area of the laser beam and leaves the remaining areas unchanged. This advantageous property of TPA can be used for controlling the laser beam focus with the optical vision and determining unit such that a three-dimensionally structured waveguide is written into an otherwise unaltered optical material.

Thus, in short, according to Bennion et al. the waveguide is inherently confined to the surface of the photochromic material, whereas the waveguide produced in the claimed method can be freely formed within the optical material by using the z-axis (perpendicular to the surface) as an additional degree of freedom.

Aside from this, the technique of Bennion et al. requires the surface of the photochromic material to be sufficiently smooth in order to prevent scattering of the guided light wave in the waveguide (p. 2, l. 37-l. 41 of Bennion et al.). This drawback is obviated in the present invention, since the waveguide can be structured within the optical material by adjusting the

focus area also in terms of the depth, such that the surface of the optical material has no influence on the light wave guided in the waveguide structure.

3. The claimed subject-matter cannot be rendered obvious including by Elchelberger et al. (EP 2 073 703 A2), either, which was only drawn upon by the Examiner with respect to the measuring of distances in the production of the printed circuit board element.

Elchelberger et al. discusses a technique for providing high density interconnections between integrated circuits on a substrate 28. First, an artwork representation for the interconnections is generated and stored in a computer data base. The artwork representation assumes the integrated circuits to be at ideal locations on the substrate 28. Then, the actual position of each integrated circuit is obtained with an imaging system using a camera 26. From a comparison between the stored ideal positions and the measured actual positions of the ICs, offsets and rotations for each IC on the substrate 28 are computed. These offsets and rotations are then used to modify the artwork representation stored in the database. The modified representation is used to drive a direct writing laser lithography system that forms the high density inter-connections of th ICs on the substrate 28.

Thus, Elchelberger et al. merely teaches the controlling of a direct writing laser in a different context, namely a lithography system. However, this prior art, even if taken in combination with Bennion et al. and with the knowledge available to a person having ordinary skill in the art, fails to give any hint at the claimed feature of determining a position of an optoelectronic component embedded in an optical layer, which is missing in Elchelberger et al., and measuring distances thereon.

In any case, Elchelberger et al. cannot heal the deficiencies of Bennion et al., as discussed

above, to arrive at the claimed invention.

Therefore, the present method of claim 21 is not only novel, but moreover nonobvious and should therefore be in condition for allowance.

4. New independent claim 50 recites the feature that the optoelectronic component is embedded in the optical layer, <u>such that one side of the optoelectronic component abuts the substrate and all other sides of the optoelectronic component are embedded within the optical material of the optical layer or the embedded optoelectronic component is completely surrounded by the optical material of the optical layer</u>. In contrast to this, Bennion et al. merely teaches an optical material between components, as discussed above. Accordingly, claim 50 is believed to be patentable for at least the same reasons as discussed above in connection with claim 21.

5. The other claims in this application are each dependent from independent claim 21 discussed above and are therefore believed patentable for the same reasons. Since each dependent claim is also deemed to define an additional aspect of the invention, however, the individual reconsideration of the patentability of each on its own merits is respectfully requested.

Conclusion

In view of the foregoing amendments and remarks, Applicants respectfully request favorable reconsideration and early passage to issue of the present application.

Respectfully submitted,

/Raymond A. DiPerna/

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